AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claims 1-30. (Cancelled)

31. (New) An automated method for frequency compensated communications reception including compensating for frequency offset in a received signal by adaptively forming a combination of basis functions and a training sequence that collectively approximate to a desired frequency-shifted signal to be acquired.

32. (New) A method according to Claim 31 including constructing a reference signal or comparison training sequence that is an adaptively formed combination of basis functions and the training sequence.

33. (New) A method according to Claim 32 for acquiring a signal with a receiver having multiple antenna elements, the method including constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a training sequence and a received signal, together with a constraint to obtain non-trivial solutions.

34. (New) A method according to Claim 33 wherein the constraint requires non-zero signal power.

35. (New) A method according to Claim 33 wherein the cost function is J given by: $J = \|\mathbf{Xw} - \mathbf{CFv}\|^2 + \lambda\left(\mathbf{w}^H \mathbf{X}^H \mathbf{Xw} - 1\right)$, where $\mathbf{X}$ is a matrix of received signal samples, $\mathbf{w}$ is a vector of beamforming weights which are adaptive to minimise J, $\mathbf{C}$ is a

diagonal matrix having elements of the training sequence on its diagonal, $\mathbf{F}$ is a matrix having columns defining respective basis functions, $\mathbf{v}$ is a vector of weights which are adaptive to minimise J, superscript index H indicates a complex conjugate transpose and λ is a Lagrange multiplier for a term to constrain beamformer output power to be non-zero.

36. (New) A method according to Claim 35 including determining the adaptive weight vectors $\mathbf{w}$ and $\mathbf{v}$ at intervals from true estimates of a correlation matrix determined from multiple data vectors and from inverses of such estimates recursively updated to reflect successive new data vectors which are rows of the matrix $\mathbf{X}$.

37. (New) A method according to Claim 36 including recursively updating inverse correlation matrices by:

a) forming a vector $\mathbf{u}(\mathrm{n})$ having a first element $\mathrm{u}_1(\mathrm{n})$ equal to $\sqrt{\mathrm{U}_{1,1}(\mathrm{n})}$ and other elements $\mathrm{u}_\mathrm{p}(\mathrm{n})$ (p= 2 to M) which are respective ratios $\mathrm{U}_{\mathrm{p},1}(\mathrm{n})/\mathrm{u}_1(\mathrm{n})$, $\mathrm{U}_{\mathrm{p},1}(\mathrm{n})$ is a pth element of a first column of a matrix $\mathrm{U}(\mathrm{n})$, the matrix $\mathrm{U}(\mathrm{n}) \equiv \mathbf{u}(\mathrm{n})\mathbf{u}^H(\mathrm{n}) = \mathbf{x}(\mathrm{n})\mathbf{x}^H(\mathrm{n}) - \mathbf{x}(\mathrm{n}-\mathrm{K}+1)\mathbf{x}^H(\mathrm{n}-\mathrm{K}+1)$, $\mathbf{x}(\mathrm{n})$ is a most recent data vector and $\mathbf{x}(\mathrm{n}-\mathrm{K}+1)$ is a least recent data vector involved in updating and $\mathbf{x}(\mathrm{n})\mathbf{x}^H(\mathrm{n})$ and $\mathbf{x}(\mathrm{n}-\mathrm{K}+1)\mathbf{x}^H(\mathrm{n}-\mathrm{K}+1)$ are correlation matrices;

b) premultiplying a previous inverse correlation matrix $\mathbf{P}(\mathrm{n}-1)$ by vector $\mathbf{u}^H(\mathrm{n})$ and postmultiplied by vector $\mathbf{u}(\mathrm{n})$ to form a product and adding the product to a forget factor to form a sum;

c) postmultiplying the previous inverse correlation matrix $\mathbf{P}(\mathrm{n}-1)$ by vector $\mathbf{u}(n)$ and dividing by the said sum to form a quotient; and

d) subtracting the quotient from the previous inverse correlation matrix $\mathbf{P}(\mathrm{n}-1)$ to provide a difference.

38. (New) A method according to Claim 32 for acquiring a signal with a receiver having a single antenna element, the method including constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a scaled received signal and a constraint requiring non-zero signal power.

39. (New) A method according to Claim 38 wherein the cost function is J given by: $J = \|\mathbf{x} - \mathbf{CFv}\|^2$, where $\mathbf{x}$ is a vector of received signal samples, and $\mathbf{v}$, $\mathbf{C}$ and $\mathbf{F}$ are as defined earlier.

40. (New) A method according to Claim 38 wherein the cost function is J given by: $J = \|\alpha\mathbf{x} - \mathbf{Gv}\|^2 + \lambda\left(\alpha^* \mathbf{x}^H \mathbf{x}\alpha - 1\right)$, where α is a scaling factor, $\mathbf{x}$ is a vector of received signal samples, $\mathbf{G}$ is a matrix equal to $\mathbf{CF}$ and $\mathbf{v}$, λ, $\mathbf{C}$, $\mathbf{F}$ and H are as defined earlier.

41. (New) Apparatus for frequency compensated communications reception including means for compensating for frequency offset in a received signal by adaptively forming a combination of basis functions and a training sequence that collectively approximate to a desired frequency-shifted signal to be acquired.

42. (New) Apparatus according to Claim 41 including means for constructing a reference signal or comparison training sequence that is an adaptively formed combination of basis functions and the training sequence.

43. (New) Apparatus according to Claim 42 having a receiver with multiple antenna elements for acquiring the received signal, the apparatus including means for constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a training sequence and a received signal, together with a constraint to obtain non-trivial solutions.

44. (New) Apparatus according to Claim 43 wherein the constraint requires non-zero signal power.

45. (New) Apparatus according to Claim 43 wherein the cost function is J given by: $J = \|\mathbf{Xw} - \mathbf{CFv}\|^2 + \lambda(\mathbf{w}^H \mathbf{X}^H \mathbf{Xw} - 1)$, where $\mathbf{X}$ is a matrix of received signal samples, $\mathbf{w}$ is a vector of beamforming weights which are adaptive to minimise J, $\mathbf{C}$ is a diagonal matrix having elements of the training sequence on its diagonal, $\mathbf{F}$ is a matrix having columns defining respective basis functions, $\mathbf{v}$ is a vector of weights which are adaptive to minimise J, superscript index H indicates a complex conjugate transpose and λ is a Lagrange multiplier for term to constrain beamformer output power to be non-zero.

46. (New) Apparatus according to Claim 45 including means for determining the adaptive weight vectors $\mathbf{w}$ and $\mathbf{v}$ at intervals from true estimates of a correlation matrix determined from multiple data vectors and from inverses of such estimates recursively updated to reflect successive new data vectors which are rows of the matrix $\mathbf{X}$.

47. (New) Apparatus according to Claim 46 including means for recursively updating inverse correlation matrices by:

a) forming a vector $\mathbf{u}(n)$ having a first element $u_1(n)$ equal to $\sqrt{U_{1,1}(n)}$ and other elements $u_p(n)$ (p= 2 to M) which are respective ratios $U_{p,1}(n)/u_1(n)$, $U_{p,1}(n)$is a pth element of a first column of a matrix$\mathbf{U}(n)$, the matrix $\mathbf{U}(n) \equiv \mathbf{u}(n)\mathbf{u}^H(n) = \mathbf{x}(n)\mathbf{x}^H(n) - \mathbf{x}(n-K+1)\mathbf{x}^H(n-K+1)$, $\mathbf{x}(n)$ is a most recent data vector and $\mathbf{x}(n-K+1)$ is a least recent data vector involved in updating and $\mathbf{x}(n)\mathbf{x}^H(n)$ and $\mathbf{x}(n-K+1)\mathbf{x}^H(n-K+1)$ are correlation matrices;

b) premultiplying a previous inverse correlation matrix $\mathbf{P}(n-1)$ by vector $\mathbf{u}^H(n)$

and postmultiplied by vector $\mathbf{u}(n)$ to form a product and adding the product to a forget factor to form a sum;

c) postmultiplying the previous inverse correlation matrix $\mathbf{P}(n-1)$ by vector $\mathbf{u}(n)$ and dividing by the said sum to form a quotient; and

d) subtracting the quotient from the previous inverse correlation matrix $\mathbf{P}(n-1)$ to provide a difference.

48. (New) Apparatus according to Claim 42 having a receiver with a single antenna element for acquiring the received signal, the apparatus including means for constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a scaled received signal and a constraint requiring non-zero signal power.

49. (New) Apparatus according to Claim 48 wherein the cost function is J given by: $J = \|\mathbf{x} - \mathbf{CFv}\|^2$, where $\mathbf{x}$ is a vector of received signal samples, and $\mathbf{v}$, $\mathbf{C}$ and $\mathbf{F}$ are as defined earlier.

50. (New) Apparatus according to Claim 48 wherein the cost function is J given by: $J = \|\alpha\mathbf{x} - \mathbf{Gv}\|^2 + \lambda\left(\alpha^* \mathbf{x}^H \mathbf{x}\alpha - 1\right)$, where α is a scaling factor, $\mathbf{x}$ is a vector of received signal samples, $\mathbf{G}$ is a matrix equal to $\mathbf{CF}$ and $\mathbf{v}$, λ, $\mathbf{C}$, $\mathbf{F}$ and H are as defined earlier.

51. (New) A computer software product comprising a computer readable medium containing computer readable instructions for controlling operation of computer apparatus for use in frequency compensated communications reception, wherein the computer readable instructions provide a means for controlling the computer apparatus to compensate for frequency offset in a received signal by adaptively forming a combination of basis functions and a training sequence that collectively

approximate to a desired frequency-shifted signal to be acquired.

52. (New) A computer software product according to Claim 51 wherein the computer readable instructions provide a means for constructing a reference signal or comparison training sequence that is an adaptively formed combination of basis functions and the training sequence.

53. (New) A computer software product according to Claim 52 for use in processing received signals acquired by a receiver with multiple antenna elements, wherein the computer readable instructions provide a means for for constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a training sequence and a received signal, together with a constraint to obtain non-trivial solutions.

54. (New) A computer software product according to Claim 53 wherein the constraint requires non-zero signal power.

55. (New) A computer software product according to Claim 53 wherein the cost function is J given by: $J = \|\mathbf{Xw} - \mathbf{CFv}\|^2 + \lambda(\mathbf{w}^H \mathbf{X}^H \mathbf{Xw} - 1)$, where $\mathbf{X}$ is a matrix of received signal samples, $\mathbf{w}$ is a vector of beamforming weights which are adaptive to minimise J, $\mathbf{C}$ is a diagonal matrix having elements of the training sequence on its diagonal, $\mathbf{F}$ is a matrix having columns defining respective basis functions, $\mathbf{v}$ is a vector of weights which are adaptive to minimise J, superscript index H indicates a complex conjugate transpose and λ is a Lagrange multiplier and the term which incorporates it is to constrain beamformer output power to be non-zero.

56. (New) A computer software product according to Claim 55 wherein the computer readable instructions provide a means for determining the adaptive weight vectors $\mathbf{w}$ and $\mathbf{v}$ at intervals from true estimates of a correlation matrix

determined from multiple data vectors and from inverses of such estimates recursively updated to reflect successive new data vectors which are rows of the matrix $\mathbf{X}$.

57. (New) A computer software product according to Claim 56 wherein the computer readable instructions provide a means for recursively updating inverse correlation matrices by:

a) forming a vector $\mathbf{u}(n)$ having a first element $u_1(n)$ equal to $\sqrt{U_{1,1}(n)}$ and other elements $u_p(n)$ (p= 2 to M) which are respective ratios $U_{p,1}(n)/u_1(n)$, $U_{p,1}(n)$ is a pth element of a first column of a matrix $U(n)$, the matrix $U(n) \equiv \mathbf{u}(n)\mathbf{u}^H(n) = \mathbf{x}(n)\mathbf{x}^H(n) - \mathbf{x}(n-K+1)\mathbf{x}^H(n-K+1)$, $\mathbf{x}(n)$ is a most recent data vector and $\mathbf{x}(n-K+1)$ is a least recent data vector involved in updating and $\mathbf{x}(n)\mathbf{x}^H(n)$ and $\mathbf{x}(n-K+1)\mathbf{x}^H(n-K+1)$ are correlation matrices;

b) premultiplying a previous inverse correlation matrix $\mathbf{P}(n-1)$ by vector $\mathbf{u}^H(n)$ and postmultiplied by vector $\mathbf{u}(n)$ to form a product and adding the product to a forget factor to form a sum;

c) postmultiplying the previous inverse correlation matrix $\mathbf{P}(n-1)$ by vector $\mathbf{u}(n)$ and dividing by the said sum to form a quotient; and

d) subtracting the quotient from the previous inverse correlation matrix $\mathbf{P}(n-1)$ to provide a difference.

58. (New) A computer software product according to Claim 52 for use in processing received signals acquired by a receiver with a single antenna element, wherein the computer readable instructions provide a means for constructing the reference signal by minimising a cost function constructed from an adaptively weighted combination of basis functions, a scaled received signal and a constraint requiring non-zero signal power.

59. (New) A computer software product according to Claim 58 wherein the cost function is J given by: $J=\|\mathbf{x}-\mathbf{CFv}\|^2$, where $\mathbf{x}$ is a vector of received signal samples, and $\mathbf{v}$, $\mathbf{C}$ and $\mathbf{F}$ are as defined earlier.

60. (New) A computer software product according to Claim 58 wherein the cost function is J given by: $J=\|\alpha\mathbf{x}-\mathbf{Gv}\|^2+\lambda\left(\alpha^{*}\mathbf{x}^{H}\mathbf{x}\alpha-1\right)$, where α is a scaling factor, $\mathbf{x}$ is a vector of received signal samples, $\mathbf{G}$ is a matrix equal to $\mathbf{CF}$ and $\mathbf{v}$, λ, $\mathbf{C}$, $\mathbf{F}$ and H are as defined earlier.